

## Claims

1. A multi-piston spool valve assembly comprising:

a spool translatable within a ported body, wherein when said spool is in a first position, a land of said spool completely obstructs a first port of said body, wherein when said spool is in a second position, said land only partially obstructs said first port, and wherein when said spool is in a third position, said first port is substantially unobstructed by said land;

a movable pilot piston operatively connected to said spool whereby movement of said pilot piston can cause a movement of said spool;

a movable stop piston that can be positioned to create a limit to the movement of said pilot piston;

a first fluid chamber, wherein said chamber is capable of being connected to a source of pressurized fluid and is operatively connected to said pilot piston whereby when pressurized fluid is within said chamber, said fluid can cause force to be applied to said pilot piston;

a second fluid chamber, wherein said second fluid chamber is capable of being connected to a source of pressurized fluid and is operatively connected to said stop piston whereby when pressurized fluid is within said second fluid chamber, said fluid can cause force to be applied to said stop piston;

wherein when said spool is in said first position and pressurized fluid is directed into said first fluid chamber but

is not directed into said second fluid chamber, said fluid in said first fluid chamber will cause the pilot piston to move and thereby cause said spool to move to said third position; and

wherein when said spool is in said first position and pressurized fluid is directed into both of said first and second fluid chambers, pressurized fluid in said first fluid chamber will cause the pilot piston to move in a first direction and cause a movement of said spool while pressurized fluid in said second fluid chamber will cause the stop piston to be located at a position where it prevents the pilot piston from moving a maximum distance whereby said pilot piston will only be capable of moving said spool to said second position.

2. The valve assembly of Claim 1 further comprising a guide member having a thru-bore that functions to guide the pilot piston's movement and wherein said guide member includes a portion that can contact and thereby limit the movement of the stop position.

3. The valve assembly of Claim 1 wherein said pilot piston, said stop piston and said first and second fluid chambers form a first piston assembly that is located adjacent a first end of said spool, and wherein a second piston assembly that is identical to said first piston assembly is located at a second end of said spool.

4. The valve assembly of Claim 1 wherein the first fluid chamber incorporates a portion of said pilot piston, and wherein the second fluid chamber incorporates a portion of the stop piston.

5. The valve assembly of Claim 1 further comprising a pusher member that is located between the pilot piston and an end of said spool, wherein said pusher member functions to transfer movement from said pilot piston to said spool and wherein the pusher member includes a portion that can contact the stop piston whereby when said stop piston and said pusher member are in predetermined positions, the stop piston can prevent movement of said pusher member toward the spool and thereby functions to limit the movement of the pilot piston.

6. The valve assembly of Claim 1 wherein said stop piston is a first stop piston, wherein said valve assembly includes a second stop piston that is movable and is located proximate said first stop piston, wherein said second stop piston can be moved to a position that limits the movement of the pilot piston, wherein a third fluid chamber is located in said valve assembly and is capable of being connected to a source of pressurized fluid, and wherein said third fluid chamber is operatively connected to said second stop piston whereby when pressurized fluid is within said third fluid chamber and said second stop piston is located in a first position, said fluid can cause said second stop piston to

move to a second position; and

wherein when said spool is in said first position and pressurized fluid is directed into said first, second and third fluid chambers, said fluid will cause the pilot piston to move in a first direction and cause a movement of said spool while pressurized fluid causes said first and second stop pistons to move to positions that limit said movement of the pilot piston whereby said pilot piston can only move said spool to a fourth position in which said land partially blocks said first port, and wherein said fourth position is different from said second position.

7. The valve assembly of Claim 6 wherein when pressurized fluid is directed into said first and third fluid chambers but not into said second fluid chamber, pressurized fluid in said first fluid chamber will cause the pilot piston to move in a first direction and cause a movement of said spool while pressurized fluid in said third fluid chamber will cause the second stop piston to move to a position where it prevents the pilot piston from moving a maximum distance whereby said pilot piston can only move said spool to a fifth position in which said land partially blocks the first port, and wherein said fifth position is different from said second and fourth positions.

8. The valve assembly of Claim 6 wherein the first and second

stop pistons are tubular in shape, concentrically-oriented and wherein movement of said first stop piston toward or away from the spool is limited by a portion of said second stop piston.

9. A multi-piston spool valve assembly comprising:

a spool translatable within a ported body, wherein when said spool is in a first position, a land of said spool completely obstructs a first port of said body, wherein when said spool is in a second position, said land only partially obstructs said first port, and wherein when said spool is in a third position, said first port is substantially unobstructed by said land;

first and second piston assemblies operatively connected to opposite ends of said spool, wherein each of said piston assemblies comprises: a movable pilot piston operatively connected to said spool whereby movement of said pilot piston can cause a movement of said spool; a movable stop piston that can be positioned to create a limit to the movement of said pilot piston; a first fluid chamber that is operatively connected to said pilot piston and is capable of being connected to a source of pressurized fluid; and a second fluid chamber that is operatively connected to said stop piston and is capable of being connected to a source of pressurized fluid;

wherein when said spool is in said first position and pressurized fluid is directed into said first fluid chamber of said first piston assembly but is not directed to said second

fluid chamber of said first piston assembly nor into said first and second fluid chambers of said second piston assembly, said pressurized fluid will cause the pilot piston of said first piston assembly to move in a first direction and thereby cause said spool to move to said third position; and

wherein when said spool is in said first position and pressurized fluid is directed into both of said first and second fluid chambers of said first piston assembly but not into the first fluid chamber of the second piston assembly, said fluid will cause the pilot piston of the first piston assembly to move in said first direction and cause a movement of said spool while pressurized fluid in said second fluid chamber of said first piston assembly will cause the stop piston of said first piston assembly to be located in a position where it prevents the pilot piston of said first piston assembly from moving a maximum distance, whereby said pilot piston of said first piston assembly will only be capable of moving said spool to said second position.

10. A multi-piston spool valve assembly comprising:

a spool translatable within a ported body, wherein when said spool is in a first position, a land of said spool completely obstructs a first port of said body, wherein when said spool is in a second position, said land only partially obstructs said first port, and wherein when said spool is in a third position,

said first port is substantially unobstructed by said land;

first, second and third fluid chambers that are each capable of being connected to a source of pressurized fluid;

a movable pilot piston operatively connected to said first fluid chamber and to said spool whereby movement of said pilot piston can cause a movement of said spool;

a first movable stop piston that is operatively connected to said second fluid chamber and can be positioned to create a limit to the movement of said pilot piston;

a second movable stop piston that is operatively connected to said third fluid chamber and can be positioned to create a limit to the movement of said pilot piston;

wherein when said spool is in said first position and pressurized fluid is directed into said first fluid chamber but is not directed to said second and third fluid chambers, said fluid will cause the pilot piston to move to a maximum extent and thereby cause said spool to move to said third position; and

wherein when said spool is in said first position and pressurized fluid is directed into both of said first and second fluid chambers but not into said third fluid chamber, pressurized fluid in said first fluid chamber will cause the pilot piston to move in a first direction and cause a movement of said spool while pressurized fluid in said second fluid chamber will cause the first stop piston to be located in a position where it prevents the pilot piston from moving a maximum distance, whereby

said pilot piston will only be capable of moving said spool to said second position.

11. A multi-piston spool valve assembly comprising:

a spool translatable within a ported body, wherein when said spool is in a first position, a land of said spool completely obstructs a first port of said body, wherein when said spool is in a second position, said land only partially obstructs said first port, and wherein when said spool is in a third position, said first port is substantially unobstructed by said land;

a movable pilot piston operatively connected to said spool whereby movement of said pilot piston can cause a movement of said spool;

a movable stop piston that can be positioned to create a limit to the movement of said pilot piston;

a first force applicator that when actuated is capable of applying a force on said pilot piston that causes a movement of said pilot piston;

a second force applicator that when actuated is capable of applying a force on said stop piston that causes a movement of said stop piston;

wherein when said spool is in said first position and then said first force applicator is actuated but said second force applicator is not actuated, said pilot piston will move and thereby cause said spool to move to said third position; and



wherein when said spool is in said first position and then both of said first and second force applicators are actuated, said pilot piston moves and causes a movement of said spool while said stop piston moves to a position where it prevents the pilot piston from moving a maximum distance whereby said pilot piston will only be capable of moving said spool to said second position.

12. A fluid control system comprising:

a spool valve assembly, wherein said spool valve assembly comprises a piston assembly and a spool translatable within a ported sleeve, wherein when said spool is in a first position, a land of said spool completely covers a first port of said sleeve, wherein when said spool is in a second position, said land only partially covers said first port, and wherein when said spool is in a third position, said first port is substantially uncovered;

wherein said piston assembly of said spool valve assembly comprises: a movable pilot piston operatively connected to said spool whereby movement of said pilot piston can cause a movement of said spool; a movable stop piston that can be positioned to limit the movement of said pilot piston; a first fluid chamber that is capable of being connected to a source of pressurized fluid and that is operatively connected to said pilot piston whereby when pressurized fluid is within said chamber, said fluid can cause force to be applied to said pilot piston; a second

fluid chamber that is capable of being connected to a source of pressurized fluid and that is operatively connected to said stop piston whereby when pressurized fluid is within said chamber, said fluid can cause force to be applied to said stop piston; wherein when said spool is in said first position and pressurized fluid is directed into said first fluid chamber but is not directed into said second fluid chamber, said fluid will cause the pilot piston to move and thereby cause said spool to move to said third position; and wherein when said spool is in said first position and pressurized fluid is directed into both of said first and second fluid chambers, pressurized fluid in said first fluid chamber will cause the pilot piston to move in a first direction while pressurized fluid in said second fluid chamber will cause the stop piston to move to a position where it prevents the pilot piston from moving a maximum distance whereby said spool will be moved to said second position;

a first pilot valve that is operatively connected to said spool valve assembly in a manner whereby it is capable of directing pressurized fluid into said first fluid chamber;

a second pilot valve that is operatively connected to said spool valve assembly in a manner whereby it is capable of directing pressurized fluid into said second fluid chamber;

a first fluid line connected to said first port;

a second fluid line connected to a second port of said spool valve assembly; and

wherein when a load is connected to one of said fluid lines and a source of pressurized fluid is connected to the other of said fluid lines and said land does not cover said first port, pressurized fluid from said source of pressurized fluid can travel between said first and second ports and to said load.

13. The Fluid control system of Claim 12 wherein the piston assembly is a first piston assembly and is operatively connected to a first end of said spool, and wherein a second piston assembly identical to said first piston assembly is operatively connected to a second end of said spool.

14. The fluid control system of Claim 13 further comprising a third pilot valve that is operatively connected to said spool valve assembly in a manner whereby it is capable of directing pressurized fluid into the first fluid chamber of the second piston assembly, wherein when said spool is in said first position and pressurized fluid is directed by the first pilot valve into the first fluid chamber of the first piston assembly, the spool is caused to move in a first direction, and wherein when said spool is in said first position and pressurized fluid is directed by the third pilot valve into the first fluid chamber of the second piston assembly, the spool is caused to move in a second direction that is opposite to said first direction.

15. The fluid control system of Claim 14 wherein said second pilot valve is capable of directing pressurized fluid into the second fluid chamber of both of the first and second piston assemblies.

16. The fluid control system of Claim 12 wherein the piston assembly includes a plurality of stop pistons that are capable of providing multiple limits to the movement of the pilot piston, wherein a first one of said plurality of stop pistons can be caused to move by pressurized fluid being directed into said second fluid chamber, and wherein a second of said stop pistons can be caused to move by pressurized fluid being directed into a third fluid chamber by a third operatively-connected pilot valve.

17. The fluid control system of Claim 16 wherein said first and second stop pistons are tubular in shape and concentrically-oriented.

18. The fluid control system of Claim 16 wherein the third fluid chamber is located between portions of said first and second stop pistons.

19. The fluid control system of Claim 12 further comprising a pusher member that is located between the piston assembly's pilot piston and an end of said spool, wherein said pusher member

functions to transfer movement from said pilot piston to said spool, and wherein the pusher member includes a portion that can contact the stop piston whereby when said stop piston is in a predetermined position, it prevents movement of said pusher member toward the spool and thereby functions to limit the movement of the pilot piston.